# solplan review

the independent newsletter of energy efficient building practice

the drawing-room graphic services ltd.
box 86627 north vancouver b.c. V7L 4L2

No. 16 *August-September 1987*

## INSIDE. . .

We are beginning to discover that our complex high-tech society is generating a multitude of man-made compounds that are a health hazard to some individuals. The severity of the problem is still difficult to determine, but indications are that increased exposure to some substances magnifies the sensitivity, so we will be hearing more about this in the future.

Recently we learned about the sick building syndrome in public buildings, a result of high levels of pollutants in the building. The quality of indoor environments is becoming of concern in homes as well. Tight draft-free construction by itself is not the problem, but the sources of contaminants must be considered.

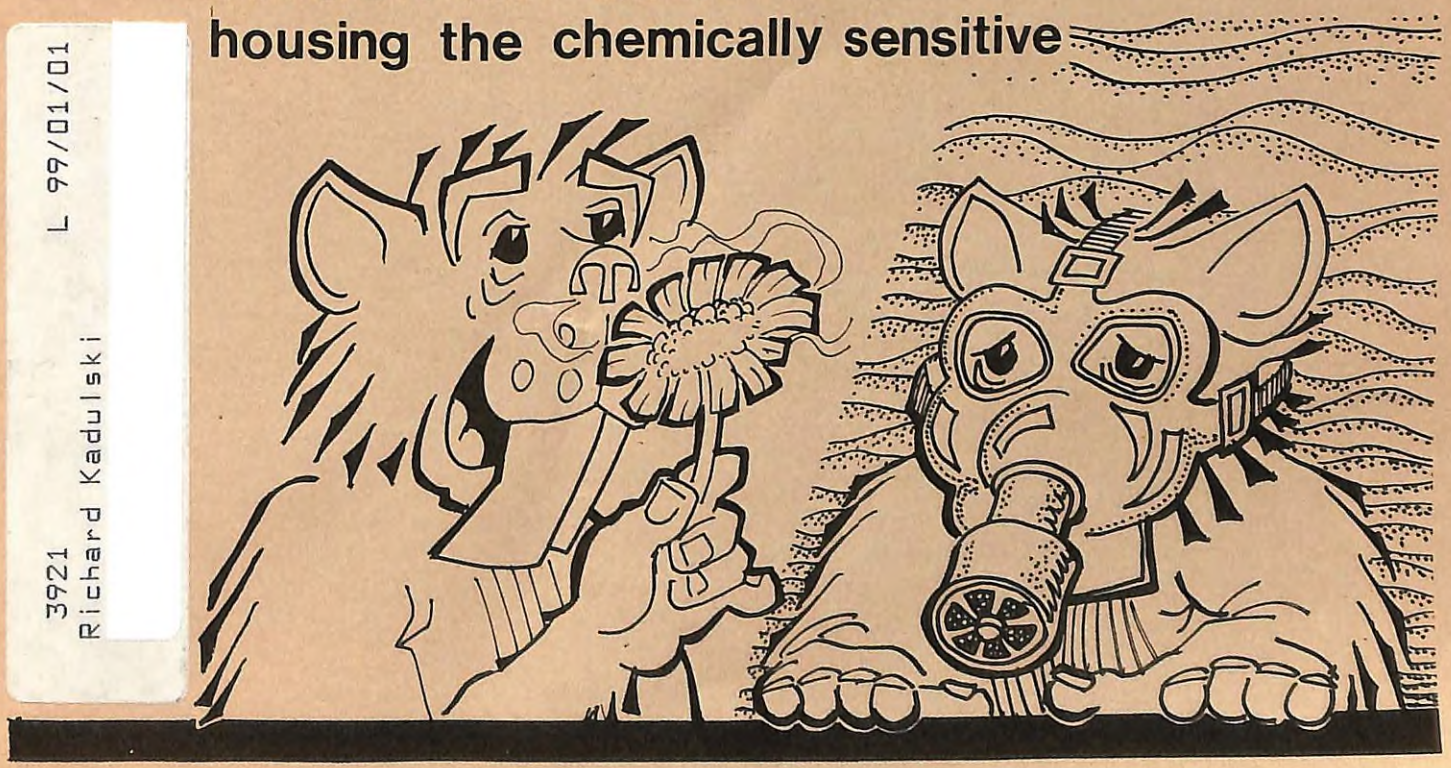
In this issue we discuss the nature of the problem, and offer a few design guidelines when building for the chemically hypersensitive.

Other items include a review of new developments in drywall manufacture, which will make the drywall an effective thermal storage element; new approaches to the air tight drywall approach; test results on the Star Heat Exchangers, and LEBCO news.

## CONTENTS



# INDOOR AIR QUALITY
## housing the chemically sensitive



## FROM THE PUBLISHER

There seems to be much confusion about what may be acceptable strategies to provide clean, healthy fresh air in houses.

That houses need ventilation is something that has entered our consciousness only in recent years with the drive to improve housing energy efficiency. There has always been an awareness that ventilation from bathrooms and kitchens was needed (but only if there weren't any opening windows in the room). Builders generally have used cheap fans of dubious quality and usually guaranteed not to be used by the homeowners because of their noise or non-performance.

New National Building Code requirements are very specific in their requirements but fuzzy about how to meet them, given the quality of the equipment presently on the market. How building inspectors are going to deal with the issue is unknown.

What doesn't help is the lack of consensus on how much and what type of ventilation is appropriate. Regulators look at what is going to keep them out of trouble, which usually means overkill ('just in case') and not necessarily what may be the right thing to do.

It seems that ventilation is being looked on to solve all potential ills (real and imagined) of a draft-free building that may be full of pollutant sources. Yet if we kept the sources of indoor contaminants out of the building in the first place, ventilation for human well being would be a simpler issue to deal with.

It is not too late to take a fresh look at what the object of ventilation is, and look at the ways of ensuring fresh healthy indoor air inside. Perhaps we should spend more time on materials research and standards?

Richard Kadulski
Publisher

## PRICE CHANGES

**SUBSCRIPTION PRICE CHANGES**

As readers are aware, SOLPLAN REVIEW is primarily subscriber driven. There are no hidden financial resources supporting us (we haven't won the lottery yet). We rely on subscription revenues to pay for postage, printing, production expenses, and (hopefully) for the time needed to research and write the material (but what's left over after Canada Post and the printers get theirs, this last one hasn't quite matched minimum wage yet).

While we accept a limited amount of advertising, our policy is not to rely on advertisers. This enables us to maintain complete editorial freedom, and not to swamp editorial content in a sea of ads.

As a result of increases in postal rates and printer's charges, we regret that we must increase the subscription rates for SOLPLAN REVIEW to $30.00 (student rate, with proof of student status: $15.00). United States and other foreign subscriptions will be payable in U.S. funds as postage to foreign addresses is higher.

Since we started publication 2-1/2 years ago, we have maintained our rates stable. We hope that we will be able to maintain this new rate for several more years.

We look forward to your continued support, and hope you will help us by letting your friends and colleagues know about SOLPLAN REVIEW, and encourage them to subscribe.

**SPECIAL OFFER:**

To encourage you to help others benefit from the information in SOLPLAN REVIEW we are offering you a $6.00 credit on your subscription or renewal for every new subscription you generate.

*SOLPLAN REVIEW is published 6 times per year by The Drawing-Room Graphic Services Ltd. Box 86627, North Vancouver, B.C. V7L 4L2*
*Tel: 604-689-1841* *ISSN: 0828-6574*

*SUBSCRIPTIONS: $30.00 per year. U.S.A. and other foreign subscriptions payable in U.S. funds.*
*Unsolicited contributions and manuscript welcome. Include self-addresses pre-stamped mailer if return requested. Publisher not responsible for loss or damage of same.*
*Second Class Mail Registration No. 6855*
*Date of Issue: September 1987* *Printed in Canada*



## INDOOR AIR QUALITY

*Control of air pollution has focussed on outdoor air. Now we are beginning to realize that high levels of contaminants can be found inside buildings as well. We've heard of the sick building syndrome, legionnaires disease and other similar ailments in public buildings where we may spend many hours each day. Concerns about health effects have pushed governments to limit (among others) indoor exposures to sidestream tobacco smoke, asbestos, formaldehyde, and radon.*

*However, most of us are at home for more than 16 hours per day. Even if indoor air pollutant concentrations in homes are low, they may be damaging to our health over a long period. How big a hazard indoor air pollution represents has not been established with any certainty.*

**WHY BE CONCERNED ABOUT INDOOR AIR ?**

While indoor air pollution is a problem for everyone, a significant number of Canadians are in a high risk category because they are part of a small but growing number of persons who have developed chemical sensitivities to common manufactured products. These may be similar to allergic reactions some suffer to foods or pollens, but in the most extreme cases, they are more serious.

How big a problem is it? There is no conclusive data, as sensitivities are individual - what is intolerable for one may be alright for the next person. Some suggestions indicate that as much as 20-25% of the population suffers some degree of sensitivity to natural or man made compounds. Fortunately not all are serious cases, but some sensitivities develop with exposure. Those suffering today may be an early warning of greater problems for more of us in the future as we continue to generate more new chemical compounds.

Until now, who would have thought that a seemingly harmless building product could be a killer? Yet that is what they may be for some individuals.

It appears that sensitivity is related to length of exposure as well as strength of contaminants. Some sufferers, were it not for actual physical seizures or other similar reactions, are often considered crazy, since they do not test positive to any standard medical tests for physical ailments but for the sufferer it is a real ailment.

As we were preparing this story, we received an unsolicited call from a lady who had to move away from Vancouver to the B.C. Interior in order to find a cleaner environment. The family is in the process of remodelling their new house to remove synthetic products, to make it more livable for her. How serious is her case? She describes having difficulty going anywhere, as exposure to certain products produces seizures severe enough she has to be rushed to hospital. (She travels with a portable oxygen supply just in case). The move to her new rural environment has already improved her condition.

Oliver Drerup, who has built several houses for the chemically hypersensitive in the Ottawa area, describes one home owner who was able to sense the presence of formaldehyde in a bag of vermiculite insulation (which is not supposed to have any) from a distance of 50 feet. Subsequent investigation revealed that a batch of the material had indeed been treated!

The positive aspect is that *removal of the objectionable products tends to desensitize the affected person over a period of time.*

The understanding of the specialized needs of hypersensitive persons needs to be developed, just as they have been for other physical handicaps. In order to prevent health problems, consumers must be educated to recognize building-related health problems and to be able to test proposed building materials and furnishings against occupant sensitivities.

What complicates the issue is that any one chemical may not be especially damaging, but combined with others it may be worse. Tighter house construction methods and reduced ventilation in order to conserve energy, without attention to indoor pollutant sources has led to levels of indoor contaminants which are dangerous to health.

R-2000 houses, because of their tight construction and filtered, controlled ventilation have improved the lot for many allergy sufferers, but they still contain many synthetic products which are potentially damaging for the ultra sensitive.

New building products, insulation and sealants are pollution sources to some. New techniques and materials are needed to achieve reasonable energy conservation without extreme levels of indoor pollution.

Contaminated indoor air is not new. Soot on ceilings of prehistoric caves shows us that pollution due to inadequate ventilation of open fires has been around for a long time. High pollutant concentrations continue to be a fact of life for poor people who live in impoverished areas and cook over open fires fueled by wood, oil, or kerosene.

The number of Canadian homes in which contaminated air presents a problem is presently unknown. The complex nature of materials found in the indoor environment in our technological society (including synthetic building materials, energy-efficient retrofit practices, cleaners and personal care products) makes for widespread indoor exposures to a large number of chemicals.

**MEDICAL UNKNOWNS**

Literature on indoor air pollution has one over-riding theme: there is not yet enough information to know for sure the full extent of health damage from indoor air pollution. All that is certain is that with the present awareness of a growing problem, research should be focussed on finding the answers.

Unfortunately because we have been slow to recognize the importance of healthful indoor air, information we have is fragmented, anecdotal, and often conflicting.

Most pollution standards in Canada and abroad have been based on industrial or outdoor factors. Neither outdoor nor industrial exposures are similar to the long-term, continuous, low-level exposure that most of us experience indoors at home.

In addition, most pollution criteria are based on studies of exposure to single chemicals, and very little is known about the combined effects of complex mixes of air contaminants. There are numerous examples of chemical interactions in which the effect resulting from exposure to a mix of chemicals is greater than the sum of the effects resulting from exposure to each chemical individually.

**WHAT ARE THE KEY POLLUTANTS?**

Major pollutants include carbon monoxide (CO), carbon dioxide ($CO_2$), nitrogen oxides, radon gas, formaldehyde, tobacco smoke, ozone, asbestos, dust and moulds, bacteria and viruses, and a host of organic chemical vapours, some of which are known or suspected carcinogens. Long-term exposures may cause higher rates of illness and mortality.

There are many gaps in our knowledge of the long-term effects of indoor pollutants on health. Yet there is no such thing as "pure" fresh air. The issue is to determine reasonable acceptable levels for the various compounds present around us, and to minimize the unnecessary use of chemicals.

There is enough evidence to support the following conclusions:

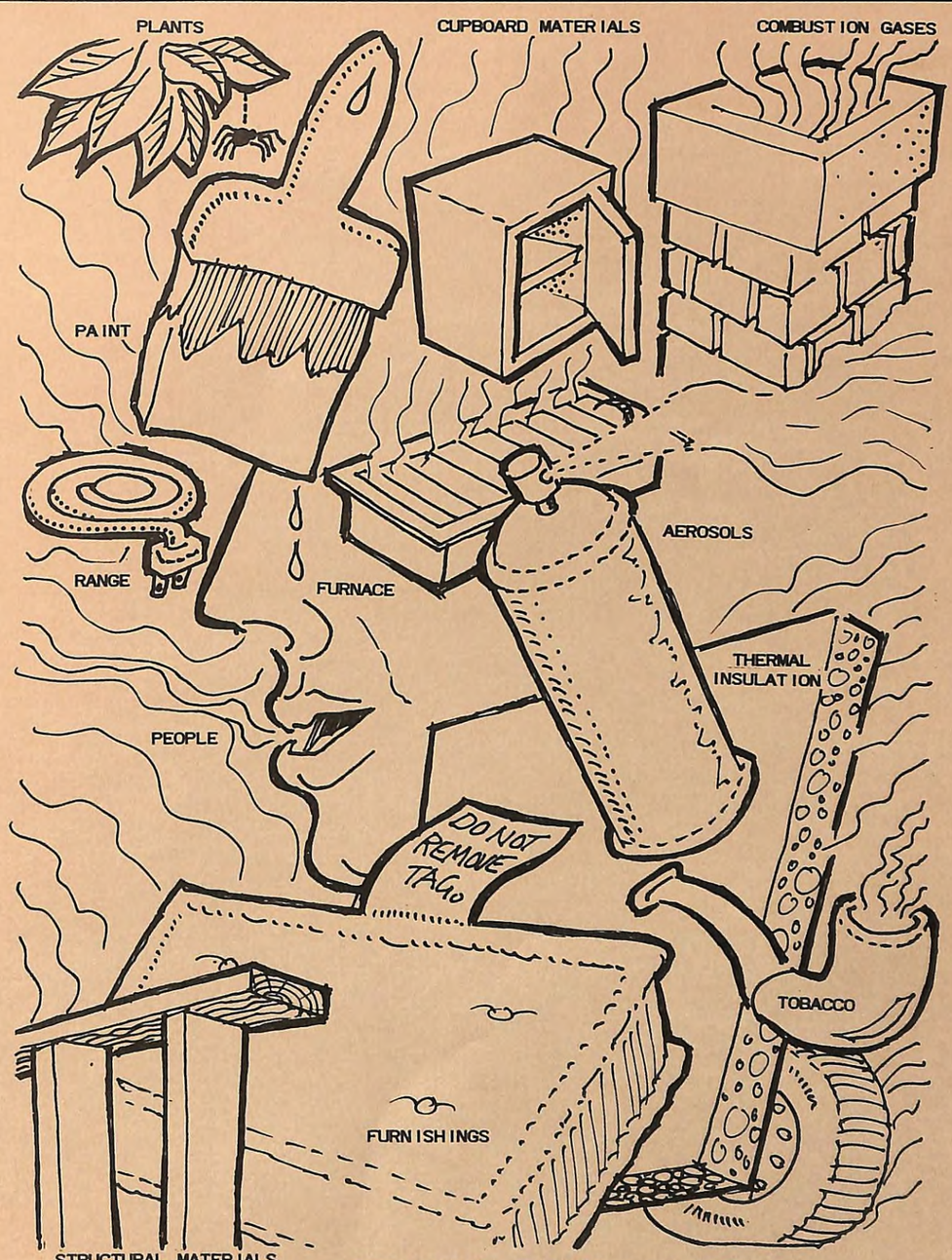
**1) Materials and conditions which contribute to indoor air pollution are present in modern homes.**
**2) Some people are more susceptible to air pollution than others, and even individual sensitivity varies over time.**
**3) Smoking is a major source of indoor air pollution.**
**4) Some energy conserving measures aggravate indoor air pollution.**
**5) The full health, social, and economic costs of indoor air pollution have yet to be determined.**
**6) Acceptable levels of effects on health from indoor air pollution have not been defined.**

Indoor combustion of fuels can be a source of CO, $CO_2$, $SO_2$, formaldehyde, hydrocarbons, nitrogen oxides and a variety of particles. Studies have noted high indoor levels of $NO_2$, NO, CO,and CO2 in homes with unvented or poorly vented appliances.

Major sources or causes of these are faulty chimney construction and furnace operation, gas stoves, unvented kerosene heaters, wood stoves, soil gases, insulation, particleboard and homes furnishings, tobacco smoking, household appliances and products, dampness, human metabolism, and widespread use of potent household chemicals including pesticides.

Exposures to $NO_2$ have been associated with toxic effects and generally increased infection rates. Some evidence indicates that increased infection in young children and adult males and lower pulmonary function performance are associated with exposure to gas stove emissions.






CONTAMINANT SOURCES IN A HOME

**Carbon monoxide** is a colourless odourless gas which is toxic at low concentrations. It enters the blood and inhibits oxygen uptake.

Carbon monoxide is produced by incomplete combustion of fuel in faulty furnaces, wood and oil stoves and heaters, smoldering fireplaces and attached garages. It is responsible for fatal accidents each year (some estimates indicate as many as 120

people per year in Canada die from CO poisoning).

**Formaldehyde** a nd other organic compounds are the compounds most commonly associated with indoor pollution. Building materials (plywood, particleboard) furnishings, and some types of foam insulation contain formaldehyde resins, the most common of which is urea formaldehyde. Formaldehyde can be released (or outgassed) over a considerable period.

Outgassing rates are higher for new materials and are directly influenced by humidity and temperature. The half-life for formaldehyde emissions is approximately 4 years (that is, half the emissions that are going to be released will do so over a period of 4 years). Unvented gas combustion and tobacco smoking are other sources of indoor formaldehyde.

Adverse effects from formaldehyde may result from inhalation, ingestion, or direct contact. As it dissolves in water, it causes irritation in the eyes and nose. Eye discomfort can happen at concentrations of 0.1 to 0.4 ppm. Residential exposures as low as 0.02 ppm can cause tearing and eye irritation.

Levels of 1 ppm can affect the central nervous system. Effects include subtle changes such as short-term memory loss, increased anxiety, and slight changes in adaptation to darkness. At concentrations of 10 to 100 ppm, formaldehyde exposures can cause respiratory irritation and pulmonary edema (fluid in the lungs). It does not appear to be a carcinogen, rather it affects mucous membranes. Its impact on the nervous system is not well understood, although psychological and neurophysical effects have been reported.

Reaction in the home environment may occur at lower exposures because of increased sensitivity due to prolonged low-level exposures. Formaldehyde concentrations as high as 1.9 ppm have been measured in homes in Europe and North America.

ACCEPTABLE LIMITS OF INDOOR LEVELS OF FORMALDEHYDE

| COUNTRY | INDOOR AMBIENT LEVELS OF FORMALDEHYDE |
|---|---|
| DENMARK | 0.12 PPM |
| HOLLAND | 0.10 PPM |
| FINLAND | 0.25 PPM |
| | 0.12 PPM* |
| ITALY | 0.10 PPM |
| WEST GERMANY | 0.10 PPM |
| SWEDEN | 0.40 PPM |
| UNITED STATES | 0.40 PPM |
| CANADA | 0.10 PPM |

* APPLIES TO HOUSES BUILT OR COMPLETELY REPAIRED AFTER JANUARY 1, 1983

**Tobacco** c ombustion indoors contributes to concentrations of respirable particles, nicotine, polycyclic aromatic hydrocarbons, CO, acrolein, $NO_2$, formaldehyde and many other substances. Concentrations vary widely, depending on the frequency of smoking, air-cleaning devices, and air distribution systems.

Nearly everyone is exposed at one time or another to tobacco smoke, although only one third of the adult population regularly smoke cigarettes.

While the health effects of smoking on smokers have been studied extensively, the health effects on nonsmokers have received far less emphasis. Many substances in cigarette smoke are irritants; nasal discomfort, cough, sore throat, and sneezing have been noted in nonsmokers exposed to cigarette smoke. Measured changes in heart rate, blood pressure, and small airway dysfunction have also been reported in nonsmokers exposed to smoke.

Evidence shows that tobacco smoking in the home is incompatible with good health of both smokers and their non-smoking companions or family. The cost of ventilation adequate to remove it is prohibitive. If people must smoke, use of a small specially-vented smoking areas is the best way to protect the health of non-smokers.

**Radon and radon decay products.** Radon is a radioactive decay product of radium, a natural trace element found in the soil and in concrete, gypsum wallboard and ground water. Radon gas can also diffuse into indoor air from the ground or well water. Higher concentrations are typically measured in basements, crawl spaces, and homes with low air-exchanges rates.

The major health concern of exposure to radon is not radon itself, but the radon "daughters" which are the by-products of radon decay. These compounds decay rapidly giving off significant radioactivity. The radon daughters attach themselves to any particles in the air they come in contact with. High concentrations when inhaled, contribute to lung cancer. Risk is directly proportional to exposure.

**Microorganisms and allergens.** A large variety of biological material is present in indoor environments. Pollen, molds, mites, chemical additives, animal dander, fungi, algae, and insect parts are known indoor allergens. Sources of indoor allergenic materials include pets, detergents, humidifier and air-cooling fluids, growth of molds and fungi on surfaces, and insects that live in dust and vents.

Temperature and humidity conditions are important for many indoor allergens. High humidity favors the growth of moulds and fungi. Tightly sealed buildings in humid climates are more prone to problems.

Prolonged exposure to some chemicals and antigens can cause sensitization. Therefore, reduced fresh air in buildings might lead to increased rates of infection and allergy. As yet there is a lack of data with which to evaluate the relation between infection and ventilation.

**CONTROL STRATEGIES**

Pollution control methods fall into five general categories: ventilation; source removal or substitution; design modifications; air cleaning; and behavioral adjustments to reduce exposures (avoidance).

**INFORMATION SOURCES**

Information on indoor air pollutants is found in a variety of places, often obscure medical and scientific journals. If you have specific questions or need more information, drop us a line and we will try to get it for you or put you in touch with someone who can.

CONTROL MEASURES FOR INDOOR AIR POLLUTANTS.

| CONTROL MEASURE | POLLUTANT | EXAMPLES |
|---|---|---|
| VENTILATION: DILUTION OF INDOOR AIR WITH FRESH OUTDOOR AIR OR RECIRCULATED FILTERED AIR, BY MECHANICAL OR NATURAL METHODS. LOCALIZED, ZONED, OR GENERAL VENTILATION. | RADON AND RADON DAUGHTERS; COMBUSTION BY-PRODUCTS; TOBACCO SMOKE; BIOLOGICAL AGENTS (PARTICLES); DUST. | EXHAUST OF GAS STOVE EMISSIONS AT STOVE; AIR-TO-AIR HEAT EXCHANGERS; BUILDING VENTILATION CODES. |
| SOURCE REMOVAL OR SUBSTITUTION: REMOVAL OF INDOOR EMISSION SOURCES OR SUBSTITUTION OF LESS HAZARDOUS MATERIALS. | ORGANIC SUBSTANCES; ASBESTOS MINERALS; TOBACCO SMOKE; FORMALDEHYDE. | RESTRICTIONS ON SMOKING; REMOVAL OF ASBESTOS; USE OF NATURAL INERT PRODUCTS; AVOIDING USE OF SYNTHETICS. |
| DESIGN MODIFICATION: REDUCTION OF EMISSION RATES THROUGH CHANGES IN DESIGN; CONTAINMENT OF EMISSIONS BY BARRIERS OR SEALANTS. | RADON AND RADON DAUGHTERS; ORGANIC SUBSTANCES; ASBESTOS MINERALS; COMBUSTION BY-PRODUCTS. | PLASTIC BARRIERS TO REDUCE RADON LEVELS; DESIGN OF BUILDINGS WITHOUT BASEMENTS TO AVOID RADON; CATALYTIC OXIDATION OF CO TO $CO_2$ IN KEROSENE BURNERS; SEALING OF PARTICLE BOARDS. |
| AIR CLEANING: PURIFICATION OF INDOOR AIR BY GAS ADSORBERS, AIR FILTERS, AND ELECTROSTATIC FILTERS. | PARTICULATE MATTER; COMBUSTION BY-PRODUCTS; BIOLOGICAL AGENTS (PARTICLES). | AIR CLEANERS TO CONTROL TOBACCO OR WOOD SMOKE; ULTRAVIOLET IRRADIATION TO DECONTAMINATE VENTILATION AIR; FORMALDEHYDE SORBANT FILTERS. |
| BEHAVIORAL ADJUSTMENT: REDUCTION OF EXPOSURE BY CHANGING BEHAVIOR PATTERNS THROUGH CONSUMER EDUCATION PRODUCT LABELING, BUILDING DESIGN, WARNING DEVICES, AND LEGAL LIABILITY. | ORGANIC SUBSTANCES; COMBUSTION BY-PRODUCTS; TOBACCO SMOKE; CHEMICAL AEROSOLS. | SMOKE-FREE ZONES; ARCHITECTURAL DESIGN OF INTERIOR SPACE; CERTIFICATION OF FORMALDEHYDE CONCENTRATION FOR HOME PURCHASE. |

## DESIGN GUIDELINES: BUILDING FOR THE CHEMICALLY SENSITIVE

**KNOW YOUR MARKET**

Understanding the types of pollutants and pollutant sources is the first step in approaching housing for the environmentally sensitive. But how is this knowledge put into practice? Obviously it is important to know what the specific sensitivities the individual concerned may have.

If you are dealing with a customer who may benefit from a super clean environment the following should provide some general guidelines on how to put this knowledge into practice. Remember that individuals have different tolerance levels to various materials. As a general rule, materials to avoid are new synthetic highly processed products.

**THE SITE**

Design for the chemically sensitive starts with the selection of an appropriate location. If soil or airborne herbicides and pesticides are of concern, farm and forest areas where spraying operations are

likely must be avoided. The new home should be situated on the windward side of these possible exposures. Where possible, be sure to consider the highest point of land, and avoid low-lying ground.

Conditions subject to atmospheric inversions are hazardous. These conditions may develop after the homeowner moves into the new home if the subdivision is new. If micro-climate conditions are not known, it may be wise to consult with a climatologist to get an assessment of inversion potential in a specific location. It may be wise, to locate on a quiet street in a stable built-up part of the community where conditions are known.

New developments present special hazards. Freshly surfaced blacktop streets, or use of herbicides and pesticides which might be used in establishing new lawns and landscaping could create problems. Homes built at a later date will probably contain many synthetic materials that are be harmful to the chemically susceptible person.

**THE FOUNDATION**

There are basically three types of foundations used in house construction: grade beam and pile types; basement (full, shallow or crawlspace that may or may not be heated), and slab on grade.

For the hypersensitive person, it is important to avoid the potential for mould growth. The first two foundation types listed are the most likely to generate conditions ideal for growing harmful moulds. The slab on grade is least likely to develop conditions that will transfer moulds into the living area.

It is absolutely important to only use additive free concrete. This will take special coordination with the supplier as pure cement and aggregate concrete is a special order rarely used! Most concretes contain a variety of additives.

**AIR BARRIERS**

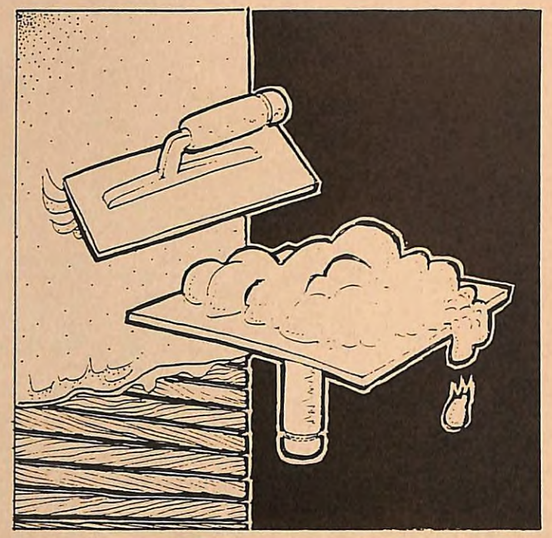
A tight air and vapour barrier is important to minimize the uncontrolled infiltration of air from the outside to the inside of the house through the building envelope. This uncontrolled infiltration could introduce toxic products from the building materials. If poly is acceptable, it can do the job. Metal foil taped with foil tape could also be suitable but it will require special care so no damage is done during construction.

With the appropriate materials, the techniques already used in low energy construction as in the R-2000 program, will help create a tight building.

**SEALANTS**

Sealants used in homes can compound problems rather than solve them. The very chemical soup used in the caulks to give them the non-hardening, workable properties we so often look for, outgass and can generate adverse symptoms. Sealant alternatives should be tested for individual reactions until a suitable substitute is found (e.g. aluminum foil barrier instead of plastic requiring caulking).

Some caulks (like certain silicones) offgass relatively quickly, and after a period of venting may be satisfactory for many sensitive persons.



**PLASTER**

Old fashioned plaster, which is so rarely seen today, is a pasty material made up of water and a caustic calcium oxide often mixed with magnesia. When it is seasoned by air-drying, it becomes a chemically stable and hardened surface of exquisite whiteness. Most sensitive individuals can tolerate this kind of wall treatment.

For aesthetic reasons the plastered inside walls and ceilings are generally painted. Modern paints are mostly made from petrochemicals and are highly volatile. This volatility results in an outgassing that disturbs most hypersensitive persons. Some paints outgass indefinitely, and so should be avoided completely.



Paints such as calcimines and acrylic paints seem to have a limited outgassing period. Following this outgassing, they may become tolerable. It is, however, not certain that all hypersensitive persons can tolerate these paints, so a test in an isolated room should be performed before deciding on a specific brand for the entire project.

**DRYWALL**

Gypsum board or drywall is mainly composed of a material similar to the lime substances of troweled plaster. However, in the plasterboard the lime is sandwiched in a strong paper binding to form the smooth finish. Drywall has been considered to be safe for the hypersensitive individual. However, some observations have been made questioning that. It is thought that some of the chemicals used for fireproofing the paper portion of the plasterboard may cause unacceptable outgassing.

A hypersensitive person should check his tolerance to a specific production lot of drywall before approving its use. Not all factories use the same chemicals, so a sensitive person might tolerate one chemical but not another.

It has been reported that one physician found it necessary to seal some drywall which was outgassing with an overlay of ceramic tile in order to tolerate the atmosphere of his private office. This suggests how costly remedial action could become if necessary.

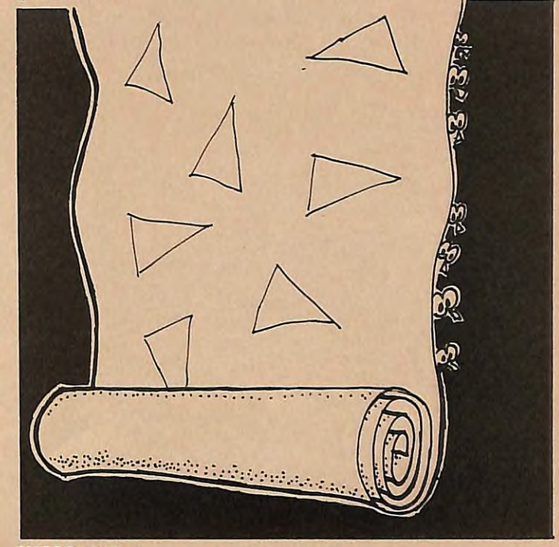
It should also be remembered that drywall requires finishing, as its appearance is less attractive than troweled plaster. Thus the problem of paints and sheet-type decorating material must be given special attention.

**WOOD**

Wood as wall-treatment material can be boards and panels. Either may be virgin stock, which will require finishing. Site applied paints and varnishes may outgass temporarily; some may outgass indefinitely.

Generally, varnish can be tolerated after a few weeks of seasoning. However, this method should not be accepted without testing for tolerance to a specific product by the hypersensitive individual.

Prefinished wood stock wall-veneers are sometimes preferred, especially if the finish was kiln dried at high temperatures. Suppliers should be able to provide specifications for specific brands of paneling.



**WALLPAPER**

Wallpaper is once again popular. Papering has its hazards for the sensitive individual. The printed decoration on the paper is made with inks and paints that outgass. The adhesives used to stick the paper to the wall can be harmful. It cannot be assumed that the outgassing will be stopped by the paper as the pores in the paper are big enough to allow passage of any molecules outgassed by pastes, glues, and other forms of adhesives.

Using homemade adhesives is not a foolproof escape from the outgassing process, as some moulds can thrive on water soluble pastes.

**FLOORING**

**Carpets** are popular, generally should be avoided. Even though Canadian made carpets have not used formaldehyde products for several years, there still are many other chemicals used in the backing materials and the synthetic fabrics themselves. As well, carpets are a great collector of dust, mites and other nasty beasties, so any person with dust allergies may have problems especially with plush carpets.

**Hardwood floors** seem to be acceptable to many but care must be paid to the finishes used. Natural oils may be tolerable. Satin polyurethane finishes seem to offgass quickly (within 8 weeks or so).

Fastening methods must be considered carefully. Adhesives used today will probably not be acceptable, so the flooring will have to be nailed in place. As well, it is important to remember that solid wood must be used. The thin wood veneer tiles on a plywood or composite board will be full of chemicals that will offgass and so should be avoided.

**Ceramic tiles** are inert and have been used satisfactorily in most situations. Again, it is important to take care in bonding them. Common practice today is to use adhesives to glue the tiles down, but the glues can be harmful. The old fashioned way of placing tiles in a cement grout (using pure cement and sand - no additives) would give better results.

**Vinyl floor** products are laced with chemicals, and would not be satisfactory.

**VENTILATION**

Controlled ventilation is essential in any new draft free house. In housing for the chemically sensitive it is especially important, as it will help control levels of contaminants that will find their way in regardless of what precautions are taken. Heat recovery ventilators are often used.

The materials used in the construction of the equipment itself should be considered as many HRV's use plastic cores. For many, these materials have not been a problem as the plastics are stable and offgass relatively quickly, but in extreme cases even this may be unacceptable. The Lifebreath units which have a metal core, may be acceptable for the extreme situations.

Controlled ventilation systems also offer the potential of adding sophisticated filtering systems. Ventilation rates used in R-2000 homes should provide adequate ventilation in a properly built house.

## LETTER TO THE EDITOR

Sir,

After reading "Tightening-Up Houses: Air Sealing Techniques" by Rob Dumont (SOLPLAN REVIEW no. 15) we felt he was leaving the impression that only the electrical outlets on the exterior walls and ceilings are a source of air infiltration.

It has been our experience in the past 20 years, as a Home Builder, and the past 2 years as a Door Fan Contractor and Air Infiltration Sealing Contractor, that the source of air infiltration through electrical outlets is not due so much to the location of the outlet in the wall or ceiling, but to the path of the wire that joins the electrical outlet to the unconditioned space (crawl space) or the outside (attic). Thus electrical outlets on interior walls have air infiltration.

We find it most effective to seal the penetration through the framing member, which the wire travels to the unconditioned space or the outside with non-expanding polyurethane foam.

We enjoy your newsletter - one of the better ones on the market.

Fred C. Bartel
Bar-Tel Infrascan
Orofino, Idaho.

**STAR HEAT EXCHANGERS ORF TESTS**

Star Heat Exchanger Corp. has completed testing of their Model 300 MPC-DV heat recovery ventilator. The unit uses axial fans and has a tube-type core. Defrosting is handled by a microprocessor chip in the unit; it recirculates ambient air through both supply and exhaust sides.

Ontario Research Foundation tests show that at 100 Pascals pressure, net airflow is 165 cfm. ORF performance test results show sensible heat recovery efficiency of 79% at 0oC (with an air flow of 117 cfm), and 67% at -25oC (with an air flow of 117 cfm).

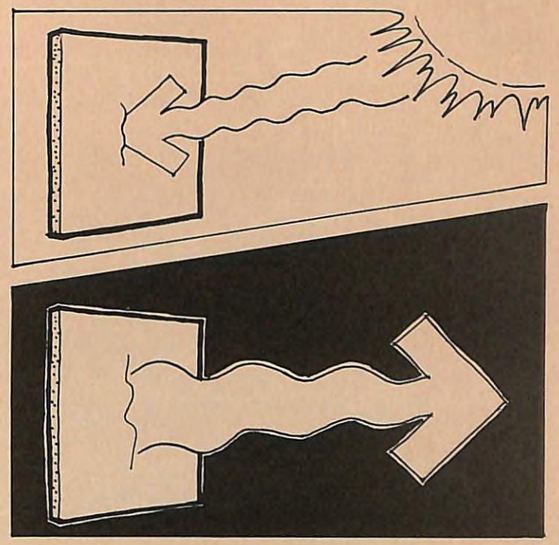
Information:
*Star Heat Exchanger Corp.*
*B-109 1772 Broadway St.*
*Port Coquitlam, B.C. V3C 2M8*
*(604) 942-0525*



## SUPER DRYWALL

*This item is about a new product we are looking forward to seeing soon that promises to significantly improve the thermal comfort of homes. Some may think it is science fiction. However, it's an exciting new development, the result of state-of-the-art research and development in Canada. It could be on the market in the not too distant future.*

*A technical paper describing this work was presented by Marvin Shapiro at the recent Solar '87 Conference in Portland, Oregon. It received recognition as the best paper at the conference by the Passive Solar Division of the American Solar Energy Society.*



The main problem in housing with large south facing glazing (and faced by passive solar designers), is the discomfort caused by large daily temperature swings.

Those who have followed activities in the solar field know that one of the key issues to harnessing solar energy is the need to store solar gains over night and for those times when the sun is not shining.

Many types of thermal storage have been looked at over the years. Reasonably cost effective thermal storage has been the use of heavy masonry elements. Concrete, solid brick walls, rock storage pits and water filled elements have all been used.

Attempts have been made to use high thermal storage capacity chemical salts which melt at low temperatures (known as phase change salts). However, the chemical composition of most of these salts contains a large amount of water. Over a number of freeze-thaw cycles, the water starts to separate from the salts and they loose their effectiveness as a heat storage element.

Direct gain passive solar designs are often sized to just meet the average January heating load. A common feature of passive solar design is the use of south facing glazing with a concrete slab (up to 6 inches thick) used for thermal storage. For the heat storage to operate properly, the surface temperature of the concrete must be able to fluctuate through a temperature swing that is more than the average swing used to calculate the storage capacity.

Also, maximum building heat losses occur near dawn, at the time the storage is coolest and delivers the least heat. Maximum heat is available from storage is when it is hottest, near sunset, at the time of least envelope losses. Fortunately this is close to the evening hours of high occupancy when solar heat is appreciated.

Auxiliary heat to warm up the house in the morning will also go into the now cooler storage mass. This may often lead to extra energy use, wasting some of the solar heat in the afternoon, reducing the overall efficiency of the passive solar system.

A number of ideas to overcome these problems have been considered, including:

1. Use of fans to increase the heat transfer from the storage surface.

2. Use of night insulation for all glazing surfaces to decrease the heating load. (In practice, there are few insulating shutter devices that really work effectively).

3. Double the storage capacity to halve the air temperature swing. This is not simple as the extra concrete thickness may not be utilized on a daily basis. If the extra concrete is not in the direct sun, more mass is required, as indirect gain gives smaller concrete average temperature swings. (Thicker slabs are not effective as there is just too much mass for proper thermal cycling).

4. Use a phase change material storage which melts in the comfort range to eliminate temperature fluctuations in the storage medium itself.

From an engineering point of view any one of these remedies, alone or in combination, will help to reduce temperature swings. However, they are also expensive and not always practical.

Research at Concordia University in Montreal done under the direction of Marvin Shapiro has developed new combinations of phase change materials which can be put into the drywall during its manufacture.

This approach provides a heat storage element at a reasonable installed cost for thermal storage with good heat transfer properties. Treating the wallboard during manufacture is not an expensive operation as it only requires a quick dip into hot phase change salts. The result is thermal storage that can be installed for very little additional cost since drywall is used in most buildings.

An even better economic return, and improved comfort is possible if more is invested into the solar design and energy conservation features to reduce the size of backup heating system required. In a good design it should be possible to rely on one or two small portable electric heaters plus the lighting - even in our cold climates. This would reduce capital costs associated with a full size heating system.

Even in well insulated buildings, when coupled to modest areas of south glazing, phase change materials can save as much fuel oil as their own weight on an annual basis. In climates where summer cooling is necessary the phase change materials can reduce air conditioning loads by storing night time ventilative cooling for use the next day.

With this kind of material, the seasonal overheating problem common to oversized masonry storage disappears. Daily temperature swings are small even with oversized storage. Even if the phase change material should melt completely after 4 to 5 sunny days in a row in September, the house will overheat, but not for long. Because of the small mass employed, only one cool night will return the phase change materials to their freezing point. One can design for 100% passive solar heating in January without fear of serious retaliation by Mother Nature in the late summer!

We will keep readers posted about developments as they happen.

## ADA: NEW APPROACHES

The use of the airtight drywall approach (ADA) has gained considerable popularity. ADA relies on the interior gypsum board as the air barrier. Seams are taped and sealed in the usual way, and sealed to other building components with gaskets and caulking. Painted with a low permeability paint, the interior finish can also serve as the vapour diffusion retarder.

As popularized by Joe Lstiburek and James Lischkoff, the ADA technique has developed many details. Lecture notes used by Joe Lstiburek (and now published in manual form by the University of Iowa) provide a number of details with many gaskets and caulking beads. This means that scheduling must be considered carefully in order to be able to maintain the continuity of the air barrier. (A few were published in SOLPLAN REVIEW No. 2 when we first described the ADA method).

Experience in the field and experimentation by builders has provided new details and approaches to ADA construction. In most cases they simplify construction.

Two Vancouver area contractors are now offering a draft-proofing service. Using ADA, they install strategically placed gaskets and caulking beads to form a continuous interior air barrier. The significant point is that <u>most</u> (but not all) of the sealing and caulking can be done <u>after</u> the regular framing has been done.

Soft Energy Systems Ltd. does this as an option to their insulation and ventilation system services, while Kenorah Construction makes their trained crew available to others on a subcontract basis. With the new National Building Code requirements for tighter construction and mechanical ventilation, this approach promises to be a good business opportunity for those so inclined. It also helps reduce the supervisory work required in the traditional poly approach. At a cost for an average house in the $750 range, it is also affordable.

A 30 unit R-2000 townhouse development in Surrey, B.C.(Western Canada's first) is being done this way.

The approach used by these specialized contractors can also be used by the builder who is doing his own work. Just what is it these contractors do? They approach the job as a retrofit after most of the framing has been completed. Obviously, work of other trades must be done with some care to avoid



situations that may be impossible to seal satisfactorily.

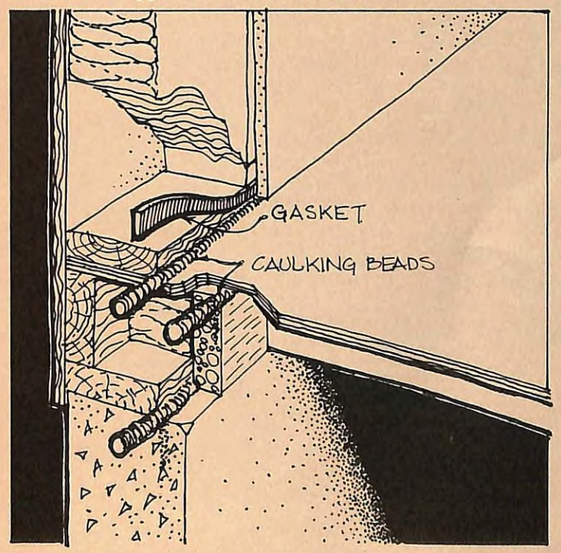
Butyl caulking is used to seal the foundation wall to the sill plate. Acrylic latex caulking is used at all points between two pieces of wood, or between wood and foam blocks. (Acoustic caulking is not used at all). All potential air leakage points are caulked. Gasketing is also used, but not nearly as much as previously shown.

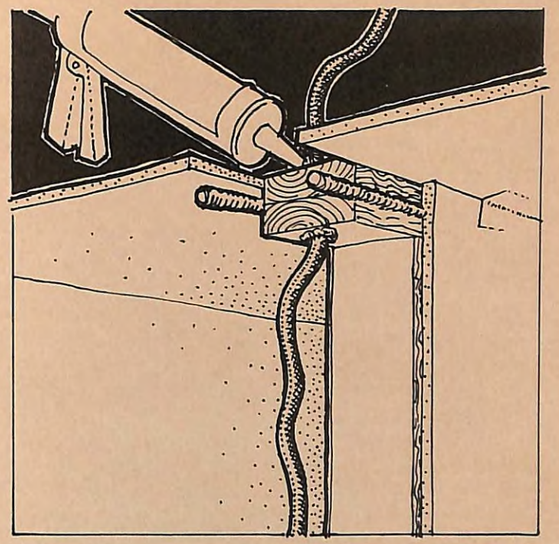
Contrary to expectations, polyethylene is still being used, but only a 2 mil poly sheet with no special attention to caulking or sealing. The purpose of the poly is to provide a vapour diffusion barrier which may or may not be backed up with a low permeability paint. It is an inexpensive back-up to paints.

Where gasketing is required, a closed cell PVC gasket with lifetime memory is used. Soft Energy lists a 1/4" x 3/8" closed cell PVC gasket for about $0.12 per lineal foot. They find a typical house needs about 1000-1200 lineal feet.

Urethane foam is often used for sealing floor joist headers and other difficult to seal places, such as plumbing penetrations in cantilevers or over unheated or awkward spaces.

Where floor headers are sealed using styrofoam blocks the joints are sealed with acrylic latex caulking, rather than acoustic caulking. This is an area subject to much shrinkage and movement. Where acoustical caulking is exposed it will set up, harden and crack over time especially if it is applied too thinly.



The amount of sealing and caulking of windows depends on the type and quality of window. The better aluminum windows, if they fit tightly into framing that is precise and square, do not receive any caulking. It has been found that caulking or gaskets around windows is not necessary. The drywall return will often be tight enough by itself. Small cracks are sealed with a silicone sealant.

When caulking or sealing it is important to ensure that the seal is continuous (especially along the sill plate). Small air bubbles or caulking applied too thinly may become air leakage points.

Drywallers must apply the board properly. A problem that crops up is when the drywaller cuts corners and does not use enough nails or screws. This is especially critical in areas where gasketing is used, because the gasket can act as a wedge keeping the drywall bowed out.

It is important to remember that one must preplan the construction from the beginning, in order to ensure that all points are covered. Also the quality of framing materials and workmanship will have a considerable impact on the effectiveness of this method. Poor lumber (full of checks, knot holes, etc.) that is very wet (or 'pond dry' as they call it on the west coast) will be more difficult to deal with as the lumber dries and checks, developing air leakage paths.

**WHY ADA?**

If you are reading or becoming interested in ADA for the first time, you should be aware of the basic underlying principles.

Current building practice has recognized the importance of building a tight envelope. Tightening the building shell was first done as an energy conservation feature to control unwanted infiltration through the envelope. Airtightness combined with controlled ventilation is important in making a house energy efficient, comfortable, and durable. A tight building envelope also reduces the amount of moisture (which is a leading cause of deterioration) that will enter the structure. Ways to achieve this tight envelope in an economical, practical and durable fashion has been the source of much experimentation.

We must remember there are two important elements in the wall as far as tightness is concerned - the air barrier and the vapour barrier. These functions can be provided by one element, or two separate ones. The air barrier is there to stop air leakage. The vapour barrier stops the migration of water vapour into the structure through the materials.

In cold climates we want a good air barrier to stop winter-time outgoing warm, moist air which is the major source of moisture that can condense in the wall. The practical way to achieve this is to use a material that is continuous, impervious to air, able to withstand air pressure loads, maintainable over the useful life of the building, and ideally is rigid. Materials such as plywood, concrete, glass, gypsum board, and plastic films make good air barriers.

Following on work done at the National Research Council in Saskatchewan in the mid 1970's the use of polyethylene, caulked and sealed carefully at all joints, was started. This meant that the polyethylene was called on to be both the air barrier and vapour diffusion retarder. However, unless the poly is of consistent quality and properly backed, it may not be the best long term material to use. The weak points are the joints. How they are treated will indicate the degree of success in the system as a whole.

The air barrier can work well regardless of its location in the building, while vapour diffusion retarders must be placed on the warm side of the dew point. The vapour barrier could be placed in the wall, but generally it should be no more than 1/3 the R value into the wall. ADA relies on the interior panelling for the air barrier.

**Caution:**

While we are showing alternative details here, we must emphasize that anyone trying ADA for the first time **must** think through exactly what they are doing. We have heard of a case where a builder described the ADA principles in his local building association's newsletter. Someone else took that to heart, and proceeded to build their next house the "ADA way". Unfortunately, they missed the whole point of what ADA is about. It led the builder to considerable trouble and much remedial work. So if this is your first try, be sure you know what you are doing!

*A book that might be of interest to first time ADA builders is* ***The Airtight House:*** *U sing the airtight drywall approach, a construction manual (by Lischkoff and Lstiburek) published by Iowa State University. It is somewhat dated but it does provide a good introduction to the subject. Copies are available to* ***Solplan Review*** *s ubscribers for US$12.95. They can be ordered directly from:*

*Iowa State University*
*Energy Extension, EES Bldg, Haber Rd.*
*Ames, Iowa 50011*

## HOUSI NG CONFERENCE

**Housing for the 90's: Meeting the Challenges of a Changing Market.** T his upcoming conference is an opportunity for builders, designers, product suppliers and project managers in government and utility programs to look at ways to stay competitive in coming years.

In addition to 75 speakers, there are 7 specialty workshops, trade show, video competition, ventilation design competition, and tours.

It is presented by the Energy Business Association, at the Sheraton Tacoma Hotel, Tacoma, Washington **November 2-5, 1987.**

For details, contact the Energy Business Association (206-622-7171) (see advertisement, back cover), or SOLPLAN REVIEW.



## LEBCO NEWS

Technical papers describing significant research developments that will have a big impact on the housing of the future, and a standing room crowd at the 1987 LEBCO Symposium are two of the highlights at **Solar 87**. the joint conference of the Solar Energy Society of Canada and the American Solar Energy Society, held in Portland Oregon, July 11-16.

The large number that turned out for the **LEBCO Symposium** w ere given a review of the state-of-the-art of low energy housing in Canada by **Rob Dumont**. He also reviewed early work in energy conservation that led to the development of the R-2000 program.

**Ken Cooper** r eviewed monitoring results of West Coast low energy and R-2000 houses. He discussed some reasons for the differences between predictions and actual performance.

**Tim Mayo** f illing in for Mark Riley, presented an overview of the new R-2000 Program ventilation guidelines.

**Oliver Drerup** g ave an eye opening overview of the issues that must be dealt with when building for the chemically sensitive. His presentation was based on personal experience building such houses.

The technical sessions at the conference had a number of papers on that will be of interest to the building community. The impact of some of this work will become evident over the next few years. In this issue we review a paper by Marvin Shapiro on a proposed drywall that will store heat, thus providing increased comfort by smoothing out temperature swings due to solar gains.

**Greg Allen** p resented his work on integrated mechanical systems. As improvements are made to the house envelope incorporating mechanical ventilation and reducing space heating loads, attention should be paid to other energy loads in the house. Greg is proposing combining all appliances which involve thermal processes using an integrated heat pump system that combines refrigeration for the fridge, whole house ventilation with heat recovery, space heating, cooling and domestic hot water heating.

While this concept may at first appear to be one of those pie in the sky concepts, it does have very sound reasoning behind it. Combining these mechanical appliances can reduce the capital cost of separate appliances. One may have a concern for the maintenance requirements of sophisticated equipment, but we forget that a refrigerator is a heat pump that provides maintenance free service for years. Scaling it up for the type of loads found in new low energy homes does not present major problems.

A feasibility analysis for the Canadian Electrical Association suggests that energy savings over separate, more conventional equipment may range from 2000 to 12000 kwh per year, depending on location, construction type and climate. An installed cost of around $3100 for the equipment is possible, at which point it is comparable if not cheaper to separate equipment (plus it offers substantial energy savings). The challenge for this approach is to get the home appliance industry together with the HVAC equipment manufacturers.

**Gold Sponsors**
Puget Sound Power & Light Co.
City of Tacoma
Bonneville Power Administration

**Silver Sponsors**
Snohomish County PUD
Washington State Energy Office
Dow Chemical U.S.A.
SWEBEX/Swedish Trade Council

**Bronze Sponsors**
American Aldes
American Plywood Association
Building Industry Association of Tacoma/Pierce County
Cadet Manufacturing
Daiken Heat Pumps
Good Energy Company/SEI
Milgard Manufacturing Inc.
Northwest Power Planning Council
John Shearer & Associates
Western Insulfoam

**Media Sponsors**
Contractors Weekly
Energy Auditor & Retrofitter
New England Builder
Progressive Builder
Solplan Review

# Housing for the 90s

## MEETING THE CHALLENGES OF A CHANGING MARKET

**Sheraton Tacoma Hotel**
Tacoma, Washington
November 2 thru 5, 1987

- Speakers & Workshops
- 75-Booth Trade Shop
- Computer Classroom
- Tours
- Ventilation Competition
- Video Competition

Examine cost-effective ways to increase marketability, comfort, and energy efficiency in housing.
Look at trends in the economy and the housing market that will shape coming challenges and opportunities.

**For more information, call or write:**
Energy Business Association
420 Maritime Building,
911 Western Avenue
Seattle, Washington 98104

(206) 622-7171

E:A
ENERGY BUSINESS ASSOCIATION

# solplan review

SOLPLAN REVIEW: THE INDEPENDENT NEWSLETTER OF ENERGY EFFICIENT BUILDING PRACTICE.
PLEASE ENTER A 1 YEAR SUBSCRIPTION TO SOLPLAN REVIEW AT $30.00 PER YEAR. (U.S.A. AND OTHER FOREIGN PAY IN U.S. FUNDS).

PAYMENT ENCLOSED PLEASE BILL US

PLEASE CHARGE TO MY CREDIT CARD:

MasterCard VISA AMERICAN EXPRESS

CARD NUMBER: _____

EXPIRY DATE: _____

SIGNATURE: _____

NAME: _____

ADDRESS: _____

_____

POST CODE: _____

STUDENTS: STUDENT SUBSCRIPTION RATE IS $15.00 PER YEAR FOR FULL TIME STUDENTS. PROOF OF STUDENT STATUS REQUIRED. ORDERS MUST BY PREPAID

**the drawing-room graphic services ltd.**
box 86627 north vancouver b.c. V7L 4L2

# AIR CHANGER


THE
ENERGY EFFICIENT
FRESH AIR SYSTEM™

- High energy recovery (efficiency).*
- High temperature recovery (effectiveness).*
- Widest range of airflows, efficiencies, control options to suit your home's individual requirements.
- Energy efficient electronic demand defrost system.
- High quality thermally broken double shell case construction.
- Easy-access panels for service from either side without core removal

* According to independent lab. testing to CSA standard C439M.
For further information, call or write:

AIR CHANGER MARKETING
7290 Torbram Rd., No. 14 Mississauga, Ont. L4T 3Y8
(416) 673-0667